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The University of Manchester

EPL Composite Solutions

Arago TECHNOLOGY

A COASTAL TRIAL FACILITY FOR HIGH VOLTAGE COMPOSITE CROSS-ARMS

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1. INTRODUCTION

A novel composite cross-arm for overhead lines has been developed. The cross-arm consists of four insulating members, end fittings, field grading devices and a nose connection for the attachment of the conductor. Following the installation of four prototype cross-arms on a decommissioned line in the Scottish Highlands, a 400 kV live trial is taking place in a coastal location of northern Scotland (Fig. 1).

2. PURPOSE OF THE TRIAL

To observe the electrical behaviour of the composite cross-arm and correlate its performance to the environmental conditions.

3. THE SITE

- Substation on the east coast of Scotland.
- A small lattice tower accommodates two cross-arms installed at an orientation of 90º from each other (Fig. 2).
- An 8 m long 400 kV conductor connects the high voltage ends of the cross-arms.
- A 50 kVA transformer energises the cross-arms at 231 kV phase-to-ground.

Figure 1 – Trial site

Figure 2 – Instrumented tower

Figure 3 – Compression member view

Figure 4 – Cross-arm view

4. PROTECTION SYSTEM

A fast, reliable and sensitive protection system was designed specifically for the trial with the following fault level requirements:

- 415 V phase-to-phase: 3031 A
- 415 V phase- to-ground: 935 A
- 415 V phase-to-phase-to-ground: 3333 A
- 231 kV phase-to-ground: 1351 A

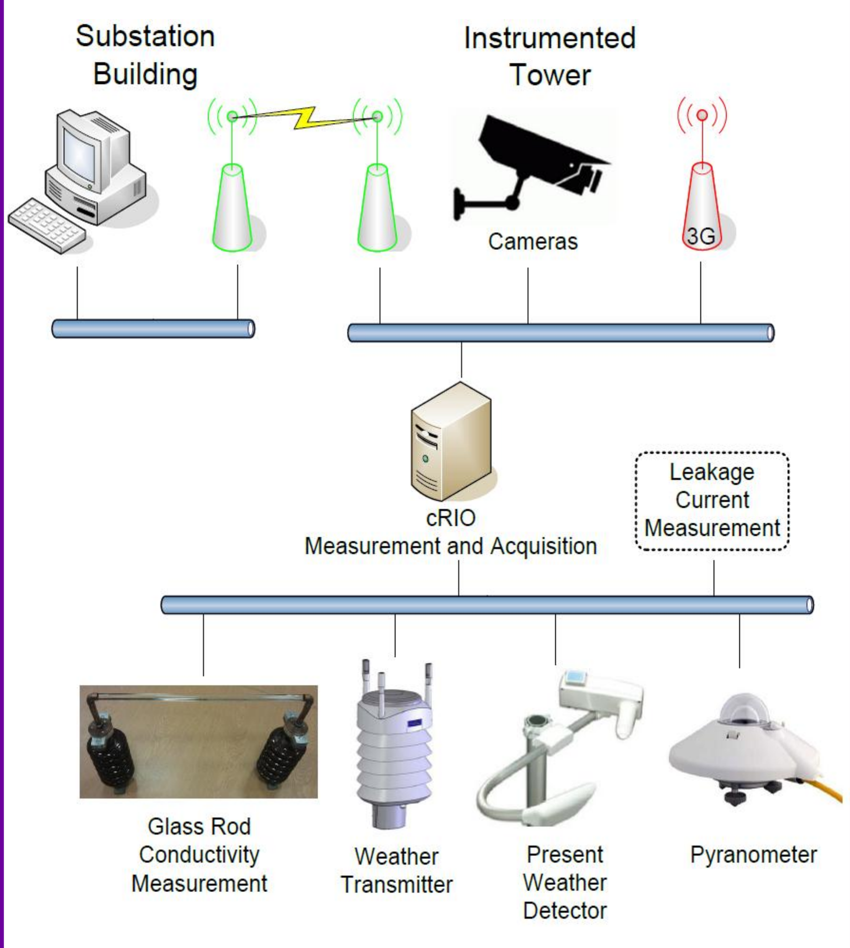

Figure 5 – Monitoring system diagram

The protection system employs the following schemes:

a) *Overcurrent protection* to protect against winding faults in the transformer.

b) *Inrush protection* to protect the system from voltage dips resulting from high magnetising inrush currents.

c) *Undervoltage protection* to complement the overcurrent protection.

d) *Differential protection* to detect phase-to-ground faults.

4. MONITORING SYSTEM

4.1 Leakage current Measurement

Shielded cables attached on the low voltage end of each member run down the tower and connect to a DAQ platform. Leakage current is measured as a voltage signal across a resistor (Fig. 7)

Figure 6 – Weather data

4.2 Weather monitoring

a) A *weather transmitter* measures wind speed and direction, precipitation, atmospheric pressure, temperature and relative humidity.

b) A *present weather detector* evaluates the prevailing visibility and weather type (no precipitation, precipitation, drizzle, rain, snow or sleet).

c) A *pyranometer* measures solar irradiance.

4.3 Cameras

One camera overlooks the entire site to provide visual confirmation regarding the weather conditions.

Another camera is focused on one of the compression members to record water behaviour and pollution accumulation (Fig. 3).

Two cameras monitor each cross-arm from above to capture snow and ice accretion patterns (Fig. 4).

5. CONCLUSION

The analysis of the results from this facility combined with electrical FEA (Fig. 8) will enhance the understanding of the performance of the composite cross-arm in preparation for deployment on a live network.

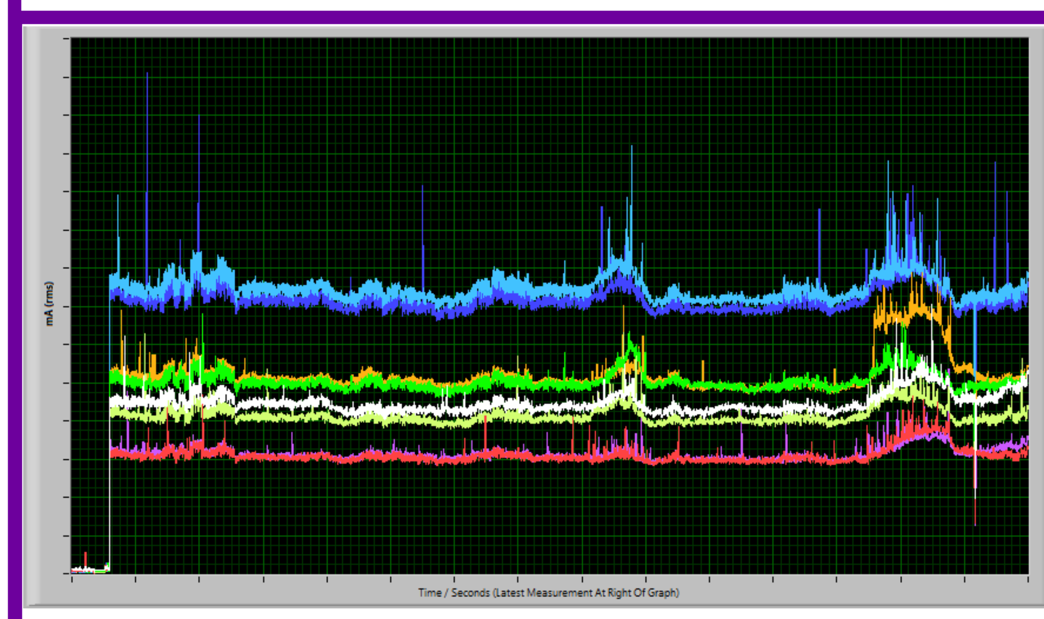

Figure 7 – Leakage current measurement

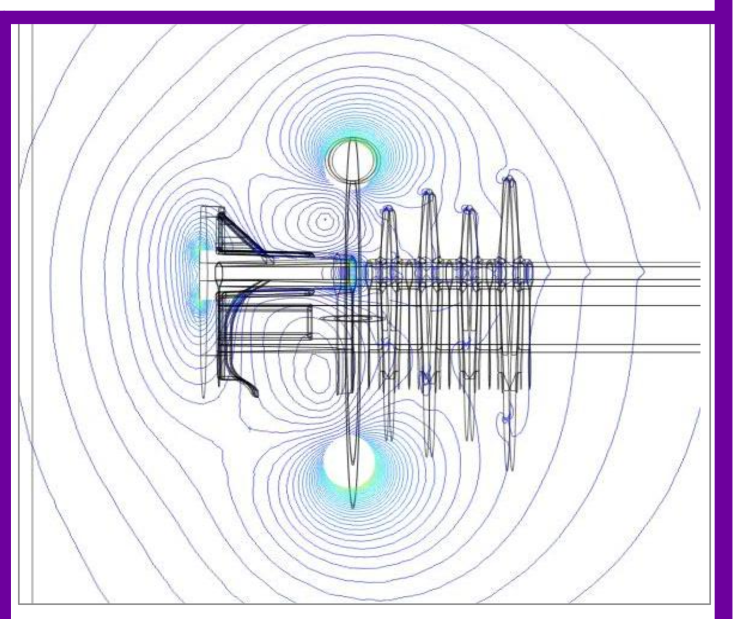

Figure 8 – Electrical FEA

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